July 27, 1954 V. G. MATHISON 2,684,670

ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

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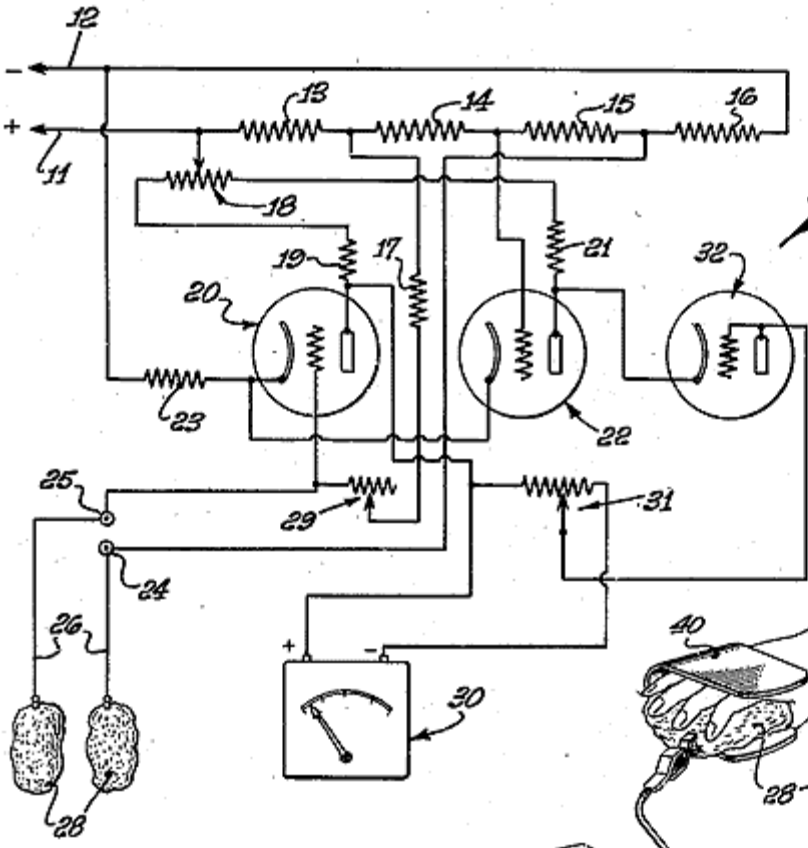



Fig. 1.

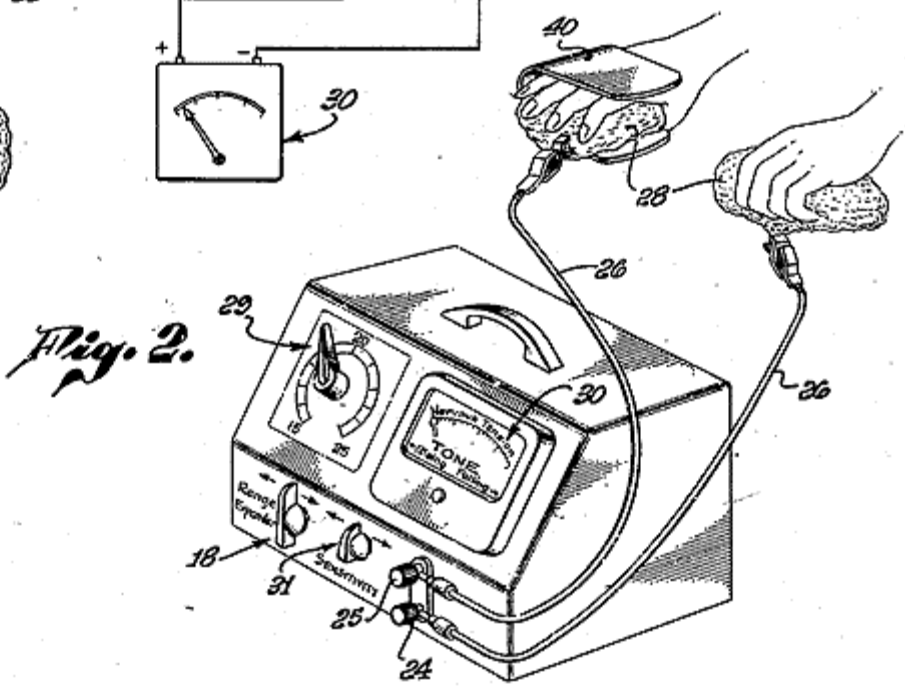
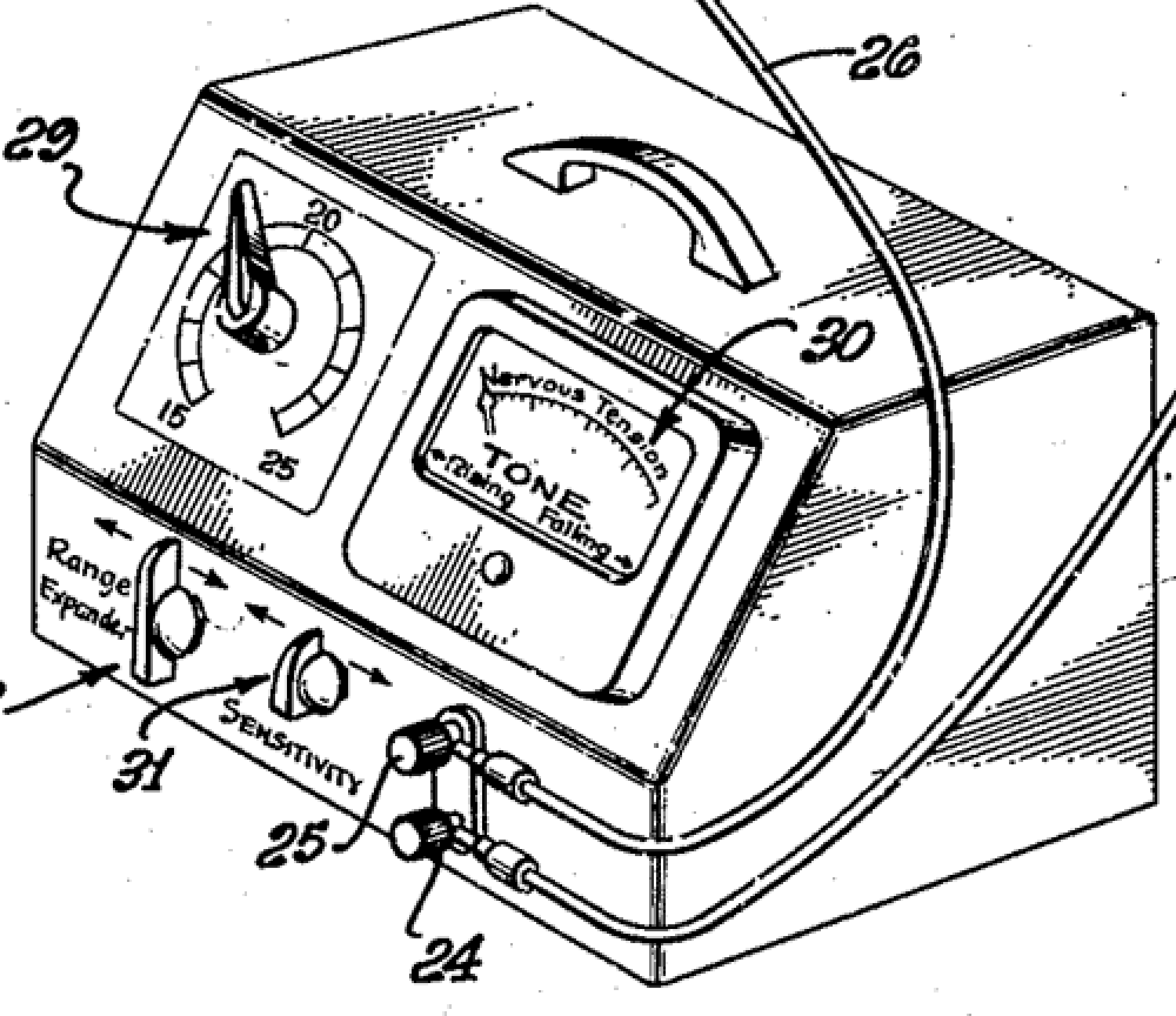



Fig. 2.

INVENTOR.

Volney G. Mathison


26
29
20
15
25
30
Nervous Tension
TONE
Ring Falling
Range Expander
31
SENSITIVITY
25
24

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# UNITED STATES PATENT OFFICE

2,684,670

## ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

Volney G. Mathison, Los Angeles, Calif.

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8 Claims. (Cl. 128—2.1)

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My invention, to which I apply the descriptive name electropsychometer, is a novel bio-electronic instrument which registers human dynamic emotion in a more accurate and sensitive manner than has been possible with any previous device of comparable simplicity.

It has been known for many years that if a subject is connected in series with a sensitive galvanometer and a source of low-potential direct current by means of electrodes brought into contact with some areas of the subject's skin, the galvanometer needle will at times register fluctuating values of current flow. Although such variations of current flow are governed, in the main, by the action of the sweat glands in the skin underneath the contacting electrodes, the rate of discharge of fluid from the sweat glands is in turn related to some extent to the activity of the subject's autonomous nervous structure. The approximate general result is that the response of the galvanometric instrument reflects in some degree the immediately prevailing nervous and emotional tone-level of the subject. In the hands of a skilled therapist, the psychogalvanometric arrangement as a whole is a valuable adjuvant in psychoanalysis and psychotherapy. Previous psychogalvanometric instruments, however, have been costly, cumbersome, and in general tend to register in a manner that has been found difficult to evaluate. For these reasons such instruments have up to this time not been much used in actual practice by psychoanalysts and psychotherapists.

My invention eliminates most of the objectionable features of the conventional psychogalvanometer and operates at a much higher level of sensitivity and accuracy. The generic combination of elements comprising my electropsychometer are: (*a*) one or more resilient and compressible skin-contacting electrodes; (*b*) a fairly simple type of balanced vacuum tube bridge; (*c*) a sensitive moving-coil type of direct current microammeter which has its winding connected into the output circuit of the amplifying vacuum tube bridge in series with a current-rectifying element, so that only rectified unidirectional current flows through the indicating instrument.

The invention is illustrated, by way of example, in the accompanying drawing, in which Figure 1 discloses the electrical circuit of the device. Figure 2 is an example of the design of an actual instrument as reduced to practice, showing the operating controls, microammeter, two resilient and compressible skin-contacting electrodes, and an electrode clamp.

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Referring to the drawing, the numerals 11 and 12 denote the positive and negative terminals of a source of direct current, which may be provided by any conventional type of vacuum-tube plate power supply, such as a small transformer, rectifier tube and filter circuit. 13, 14, 15, 16 comprise a group of four resistors connected in series across the plate current supply terminals 11, 12, to form a voltage divider. 18 is an adjustable wire-wound potentiometer. One end of 18 is connected through a resistance 19 to the plate element of vacuum tube 20. The other end of 18 is connected through a resistance 21 to the plate element of a second vacuum tube 22. The cathode elements of vacuum tubes 20, 22, are connected in common to one end of a resistance 23. The other end of 23 is connected to the negative terminal of the plate power supply, 12.

A terminal post 24 is connected between resistors 15 and 16. A second terminal post 25 is connected to the grid element of vacuum tube 20. Two flexible conductors 26 are connected to terminal posts 24 and 25. The other ends of the conductors 26 are connected to two resilient and compressible skin-contacting electrodes 28.

An adjustable resistance 29 is connected to the grid element of vacuum tube 20. 29 is also connected to a resistance 17. The other end of 17 is connected between resistors 13 and 14. A wire is connected from the plate element of vacuum tube 20 to the positive terminal of a direct-current microammeter 30. The terminals of microammeter 30 are shunted by an adjustable resistance 31. The movable arm of 31 is connected to the plate element of a vacuum tube which is connected to function as a highly conductive diode. The cathode element of 32 is connected to the plate element of vacuum tube 22. The grid element of vacuum tube 22 is connected to a point between resistors 14 and 15.

The potential across the terminals 11 and 12 may be of about 250 volts. The resistances may be of approximately the following values: 13, 24,000 ohms; 14, 680 ohms; 15, 680 ohms; 16, 18,000 ohms; 17, 12,000 ohms; 18, 20,000 ohms; 19, 15,000 ohms; 21, 22,000 ohms; 23, 15,000 ohms; 29, 50,000 ohms; 32, 10,000 ohms. Vacuum tubes 20 and 22 may be 6J5's. A twin type of vacuum tube functioning as two amplifiers in a single envelope may be substituted for vacuum tubes 20 and 22. 32 may be a 6J5 connected to function as a diode rectifier. The microammeter 30 may have a range of from zero to 50 microamperes. Any sensitive moving coil type of instrument may be used.

The skin-contacting electrodes 26 may be made of woven metallic fabric formed into the approximate shape of natural sponges and having characteristics of resiliency and compressibility. The electrodes 26 may be applied to the subject by having him clasp them in his hands. One electrode may be retained against the inside of the palm of one hand by means of a U-shaped clamp 40. Flexible conductors 26 are attached to terminal posts 24 and 25. Resistances 29 and 18 are adjusted until a reading is obtained somewhere on the low-current area of the indicating scale of the microammeter 30. Psychoanalysis or psychotherapy may now proceed. Surges of the pointer of the microammeter toward higher current readings on the indicating scale signify relatively rising degrees of emotion or of nervous tension in the subject to which the electrodes 26 are attached.

Variations in ohmic resistance between the skin-contacting electrodes 26 cause variations of electrical potential to appear at the terminals of the indicating microammeter, 30.

The flow of current through 30 is unidirectional and irreversible, because of the action of the rectifying element 32 connected in series with the indicating instrument. If the subject who is undergoing examination or therapy lets go of one of the skin-contacting electrodes, the resulting reversed potentials that would otherwise instantly appear at the terminals of the microammeter are blocked by the high reverse-current resistance of the rectifying vacuum tube 32, and the pointer of the indicating instrument moves smoothly to zero. The terminals of the microammeter 30 are shunted by an adjustable resistance 31, which acts as a damping circuit and at the same time operates as a sensitivity control.

The invention functions in the following novel manner: Firstly, it utilizes the psychogalvanic reflex level, or ohmic skin and body resistance value of the subject. Secondly, upon the flow of current through the indicating microammeter related to the subject's psychogalvanic reflex level I have superimposed a rapidly varying additional value of rectified and unidirectional current which is obtained through the use of one or more resilient and compressible electrodes grasped by the fingers of the subject. The use of these resilient and compressible electrodes enables me, in effect, to translate the delicate and ordinarily imperceptible tensing and relaxing of the muscular structure of the subject's arms and hands into special additional fluctuations of resistance value in the subject's skin and body circuit, and thereby to obtain a new means for varying the potentials appearing at the grid elements of the amplifier input circuit. The amplified fluctuating values of potential caused by this means to appear in the plate circuits of the vacuum tube bridge are converted by the rectifying element 32 into varying values of unidirectional current at the terminals of the direct-current microammeter 30.

The invention thus takes advantage simultaneousy of a plurality of reflexes of the human physical and nervous structure; firstly, the psychogalvanometric reflux involving the sweat glands of the skin, and, secondly, muscular reflexes involving slight variations of muscular tension in the arms, hands, and fingers, related to impulses registering, sometimes with considerable rapidity, in the subject's nervous structure. The utilization of the above-described dual reflex principle, combined with the use of a current rectifying element in series with a sensitive direct-current indicating instrument, results in an instrument which functions at such a high degree of rapidity and sensitivity that the subject can rarely, if ever, inhibit the registration of accurate and adequate responses during analysis or therapy.



A number of variations in the manner of attaching the electrodes to the subject are possible. An electrode may be grasped in one hand and the second electrode may be applied to some other part of the body. Systemic arrangements comprising a plurality of negative electrodes connected in parallel, or a plurality of positive electrodes in parallel, or both, may be used. The instrument functions effectively with one resilient and compressible electrode and one non-resilient electrode. If this combination of electrodes is used, the resilient electrode may be placed in the subject's right hand, and the non-resilient electrode in the subject's left hand, in the case of a right-handed subject, or oppositely in the case of a left-handed subject.

It is immaterial whether the rectifier tube 32 is connected between the plate element of vacuum tube 22 and the microammeter 30, or between the plate element of vacuum tube 20 and the microammeter, as long as the polarity requirements of the rectifying device are observed.

The registrations observed on the scale of the indicating microammeter are rapid, sharp, and highly informative to the professional psychoanalyst or psychotherapist. The instrument facilitates both diagnosis and therapy. It detects the presence of even a slight degree of narcotization. It has a decisive effect on the prospective patient, as he may be permitted to observe actual registrations of his own non-normal responses to interrogative data. One of the outstanding advantages of the invention is that it insures against an unconscious misevaluation of factors in a case that might result from some personal psychic trauma in the history of the psychotherapist himself. The instrument discloses resentment or resistance in a patient toward therapy or especially toward the practitioner, resulting from something done or said to the patient by the therapist. This consequently results in raising the level of rapport and communication between the patient and the therapist to a level rarely obtained by any other means.

The instrument is convenient to operate. A lever attached to the adjustable resistance 29 reads on a numbered scale and indicates the general emotional and nervous tone-level of the patient. The numeration on this scale may be arbitrary, rather than ohmic. Adjustable resistance 18 functions as an expander of the over-all ohmic range of the instrument. Adjustable resistance 32 controls the sensitivity of the instrument.

Quiescent readings on the indicating scales of the instrument reflect resistance values prevailing in the patient's skin and body circuit and are related in some degree to the nervous condition of the patient. Such readings should be viewed in the light of the general experience and judgment of the therapist. Dynamic fluctuations of the current flowing through the indicating microammeter and rectifying element, however, considered in a time-sequence sense, are highly significant.

I claim:

1. A bio-electronic instrument which registers

the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing any kind of psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, means for establishing a difference of electrical potential between the said electrodes, two amplifying vacuum tubes, means for connecting the grid element of one of the said vacuum tubes to one of the aforesaid skin-contacting electrodes, the plate element of the said vacuum tube being connected to the positive terminal of a moving-coil type of current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the plate element of the second amplifying vacum tube, means for establishing a biasing potential at the grid of the said second vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of both of the above-mentioned vacuum tubes, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tubes so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil indicating instrument.

2. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing any kind of psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, one or more of the said skin-contacting electrodes being resilient and compressible, means for establishing a difference of electrical potential between the said electrodes, two amplifying vacuum tubes, means for connecting the grid element of one of the said vacuum tubes to one of the aforesaid skin-contacting electrodes, the plate element of the said vacuum tube being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the positive terminal of a current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the plate element of the second amplifying vacuum tube, means for establishing a biasing potential at the grid of the said second vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of both of the above-mentioned vacuum tubes, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tubes so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil indicating instrument.

3. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing any kind of psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, means for establishing a difference of electrical potential between the said electrodes, two amplifying vacuum tubes, means for connecting the grid element of one of the said vacuum tubes to one of the aforesaid skin-contacting electrodes, the plate element of the aforesaid vacuum tube being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the positive terminal of a moving-coil type of current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the plate element of the second amplifying vacuum tube, means for establishing a biasing potential at the grid of the said second vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of both of the above-mentioned vacuum tubes, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tubes so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil indicating instrument.

4. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing any kind of psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, one or more of the said skin-contacting electrodes being resilient and compressible, means for establishing a difference of electrical potential between the said skin-contacting electrodes, two amplifying vacuum tubes, means for connecting the grid element of one of the said vacuum tubes to one of the aforesaid skin-contacting electrodes, the plate element of the said vacuum tube being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the plate element of the second amplifying vacuum tube, means for establishing a biasing potential at the grid of the said second vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of both of the above-mentioned vacuum tubes, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tubes so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil indicating instrument.

5. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, means for establishing a difference of electrical potential between the said electrodes, a twin type of vacuum tube functioning as an amplifier, means for connecting one of the grid elements of the said vacuum tube to one of the aforesaid skin-contacting electrodes, the plate element associated with the said grid element being connected to the positive terminal of a moving-coil type of current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the plate element of the second section of the aforesaid twin type vacuum tube, means for establishing a biasing potential at the grid of the said second section of the aforesaid twin type vacuum tube, means for applying electrical operating potentials between the plate elements and the cathode elements of the above-mentioned vacuum tube, means for adjusting the values of one or more of the resistance elements associated with the

above-mentioned vacuum tube so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil current-indicating instrument.

6. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, one or more of the said electrodes being resilient and compressible, means for establishing a difference of electrical potential between the said electrodes, a twin type of vacuum tube functioning as an amplifier, means for connecting one of the grid elements of the said vacuum tube to one of the aforesaid skin-contacting electrodes, the plate element associated with the said grid element being connected to the positive terminal of a current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the plate element of the second section of the aforesaid twin type vacuum tube, means for establishing a biasing potential at the grid of the said second section of the aforesaid twin type vacuum tube, means for applying electrical operating potentials between the plate elements and the cathode elements of the above-mentioned vacuum tube, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tube, so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil current-indicating instrument.

7. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, means for establishing a difference of electrical potential between the said electrodes, a twin type of vacuum tube functioning as an amplifier, means for connecting one of the grid elements of the said vacuum tube to one of the aforesaid skin-contacting electrodes, the plate element associated with the said grid element being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the positive terminal of a moving-coil type of current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the



plate element of the second section of the aforesaid twin type vacuum tube, means for establishing a biasing potential at the grid of the said second section of the aforesaid twin type vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of the above-mentioned vacuum tube, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tube so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil current-indicating instrument.

8. A bio-electronic instrument which registers the varying degrees of tension and emotion that may exist in the general physical and nervous structure of a person undergoing psychoanalysis or psychotherapy, comprising two or more skin-contacting electrodes, one of the said electrodes being resilient and compressible, means for establishing a difference of electrical potential between the said electrodes, a twin type of vacuum tube functioning as an amplifier, means for connecting one of the grid elements of the said vacuum tube to one of the aforesaid skin-contacting electrodes, the plate element associated with the said grid element being connected to the anodic terminal of a current-rectifying element, the cathodic terminal of the said current-rectifying element being connected to the positive terminal of a current-indicating instrument, the negative terminal of the said current-indicating instrument being connected to the plate element of the second section of the aforesaid twin type vacuum type, means for establishing a biasing potential at the grid of the said second section of the aforesaid twin type vacuum tube, means for applying electrical operating potentials between the plate and cathode elements of the above-mentioned vacuum tube, means for adjusting the values of one or more of the resistance elements associated with the above-mentioned vacuum tube so that variations in ohmic resistance occurring between the above-described skin-contacting electrodes are registered by the aforesaid moving-coil current-indicating instrument.

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